BLAST AND GUNSHOT INJURIES

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At the scene of a bomb explosion

- Do not enter area until told it is safe (risk of second explosion)
- Do not touch anything other than that essential to provide care
- Do not disturb dead bodies except for the minimum required to confirm death
- Be aware of an increased risk of cardiac emergencies among bystanders due to fear and panic

In the resuscitation room

- Employing standard trauma life support is the priority
- Bag, seal, and label all of the patient's clothing and personal belongings
- Label any missile fragments found and hand them directly to the police
- If the patient is stable make notes of the position and size of all wounds (retain a personal copy)

The incidence of blast and gunshot injuries is increasing throughout the world. This article deals with management problems that are specific to these injuries.

Doctors and nurses treating patients who have blast or gunshot injuries should remember that in nearly all cases there will be forensic or medicolegal consequences and that, although patient care is of prime importance, they have certain duties to record information with these consequences in mind. Such information may be required in subsequent legal prosecution or to help the victims to obtain adequate compensation. Accurate record keeping with retention of a personal copy for the long term is important.

The early management of patients who have suffered bomb blast or gunshot injuries is the same as for those with other injuries, and the patient should be managed with the same systematic approach in the primary and secondary surveys and definitive management. Certain specific actions must be taken, however, because of the mechanism of injury.

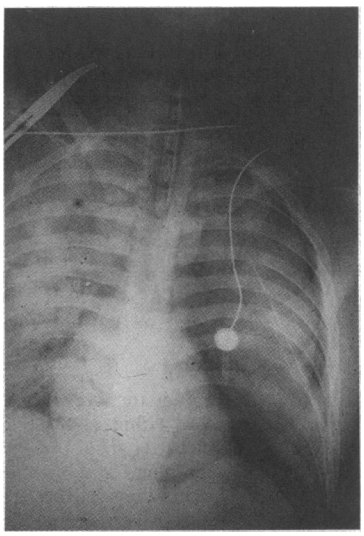
Injuries caused by explosions

Blast injuries are caused by → **Shock waves** / **Blast winds**

Blunt trauma, especially to the head, is common in people injured as a consequence of an explosion. It may be due to either translocation or a phenomenon such as the collapse of a building.

Flash burns may occur, or more serious burns, with the risk of smoke inhalation, may follow secondary conflagration. These injuries are managed as described in the article in this series on major burns.

The specific injuries caused by explosions may be those due to blast or penetrating missiles, or both, set in motion by the explosion. Blast injuries may be caused by either shock waves or columns of air set in motion by the explosion, which are known as blast winds.



Radiographic appearance of blast lung a few hours after injury.

Shock waves

A shock wave is a front of high pressure travelling at just over the speed of sound. When reflected by solid objects it may be multiplied severalfold. The circumstance in which injury occurs is therefore of prime importance—that is, the severity of injury is likely to be increased in victims of explosions in enclosed spaces or water.

The mechanism by which shock waves damage the body is multifactorial. Clinically, the shock wave produces tissue damage mainly at gas-tissue interfaces, and, therefore, serious lesions tend to be found in the upper and lower respiratory tracts and the abdomen. In the nasal air passages there may be damage to the olfactory nerve endings, producing anosmia. The tympanic membranes may be ruptured: this is a useful clinical indicator that exposure to significant blast has occurred, but as blast waves may be unpredictable the converse does not necessarily hold.

Management of blast injuries

(1) Thorough examination includes:

- Chest—examine for signs of respiratory failure and pneumothorax
  —perform chest radiography to exclude pneumothorax: examine baseline appearance of lung fields, for signs of the adult respiratory distress syndrome, and for free gas under the diaphragm
- Abdomen—examine for local peritonitis and bowel sounds
- Central nervous system—examine for abnormal signs
- Funduscopy for air emboli
- External auditory meati for perforated tympanic membranes
- Olfactory function (for medicolegal compensation)

(2) Treatment. Confine patient to a chair or bed to prevent exertion

- Give oxygen by mask
- Maintain ventilation if there is respiratory failure, but balance against the risk of embolism
- If intermittent positive pressure respiration is elected consider prophylactic chest drains
- Treat other injuries as necessary
- Perform laparotomy in cases of definite perforation

(3) If exposed to appreciable blast, **even if no injury is apparent**, observe patient for 48 hours.

Lung damage presents clinically in two ways

(1) As a sudden severe massive contusion producing instant, usually fatal, respiratory failure

(2) Diffuse lung damage may develop, the onset of which may be delayed for up to 48 hours. Such damage, from which survival is possible, may occur in up to 5% of those injured by explosions. The clinical presentation is similar to that of the adult respiratory distress syndrome, with increasing respiratory failure and radio-opacity of lung fields, but is coupled in some cases with air entering the circulation, producing small arterial air emboli, which in turn may produce secondary damage. Air may continue to enter the circulation for some time after exposure to a blast, and the risk is theoretically increased with positive pressure ventilation. Intermittent positive pressure respiration and, more definitely, positive end expiratory pressure should therefore be avoided if possible. Diagnosis may sometimes be confirmed by the presence of air in the retinal vessels. Clinically, central nervous system damage may become apparent. Pneumothoraces, with or without tension, can occur. Deterioration may be precipitated by any form of exercise, however mild.

Massive damage to major abdominal organs occurs but is rarely seen in those who survive blast injuries. The common intra-abdominal injuries in survivors are multiple contusions with haemorrhage in the subserous, intramuscular, and submucosal planes of the viscera. Acute intestinal perforation may occur, but more commonly this is delayed for as long as five days. Such perforation is due to necrosis secondary to ischaemia at the site of the haematomas. There may be diffuse abdominal pain and tenderness, but, because there inevitably is concomitant pulmonary injury, with its associated anaesthetic risk, laparotomy should be reserved for those patients in whom there is clear evidence of perforation—that is, localised peritonitis or free air on radiography.

Traumatic amputation caused by blast winds.

Blast winds

Blast winds are responsible for the severe disintegration and dismemberment caused by explosions, but these are usually fatal. Occasionally, people suffer severe traumatic amputations which they can survive. These amputations are avulsion in type and hence the limbs are unsuitable for reimplantation.

Injuries caused by penetrating missiles

Simple gunshot wound showing entry and exit.

Free missiles travelling at speeds such that penetration of the body results are usually initiated by an explosive device. They include fragments from the casing of bombs, fragments from structures near the device, buckshot from a shotgun, and bullets from small firearms. Except for the case of bullets multiple injury is the rule, but similar pathology is caused by all missiles, and the subsequent management is common to all of the injuries.

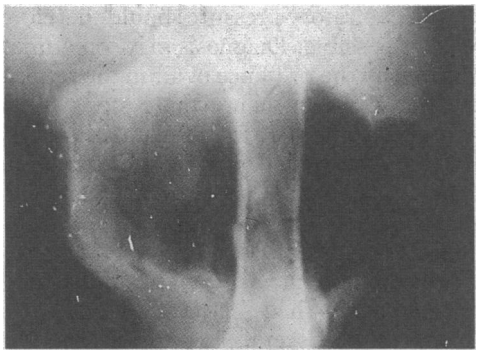
Missile and bullet injuries

Important points

- Employ standard trauma life support (Airway, Breathing, Circulation)
- If chest penetration is possible suspect tension pneumothorax
- Could the missile have injured the abdomen? If so, the prognosis is then compromised and surgical exploration is usually essential. Administer broad range antibiotics and tetanus prophylaxis early
- Wounds may be multiple, requiring thorough examination (patients are often unaware of wounds)
- Suspect that minor wounds may contain foreign bodies—perform radiography

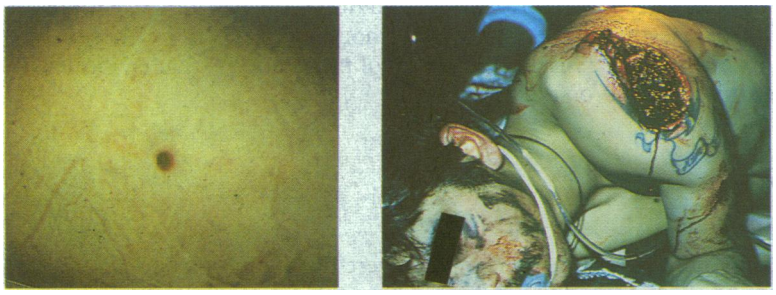
These injuries are the most common after those caused by bomb explosions.

Injury is produced in two ways. Firstly, the missile may crush and lacerate tissue in its track, and if the anatomical configuration of the track passes through viscera or major blood vessels death or life threatening conditions may result. Secondly, during retardation of the missile some or all of its kinetic energy is transferred to the target; these wounds are classified according to whether or not the amount of energy transferred is such as to produce significant damage outside the track. Any of the missiles described may have the potential to produce a high energy transfer wound. Even if the exact circumstances are known it may be impossible to predict the degree of energy transfer. The amount of energy deposited for any given bullet will depend on its position in flight, the range, the weapon, and the type of target struck. In general, bullets from rifles and machine guns have a greater potential to produce high energy wounds than those from hand guns and most bomb fragments.



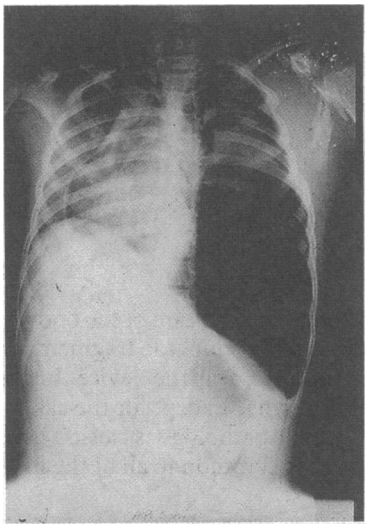
Radiograph showing cavitation effect within the tissues produced by high energy transfer.

The pathology produced by high energy transfer is tissue damage outside the missile track. Macroscopically there may be disruption of solid or semi-solid viscera, while in elastic tissues in the limbs there will be a stripping open of tissue planes for some distance from the track. Within the abdomen there may be disruption of hollow viscera caused by the associated pressure changes. Microscopically there will be large areas of non-homogeneous tissue damage with some cell death and much microvascular instability, producing ischaemia in some parts, which may be reversible. Such tissues are particularly prone to infection, especially by anaerobic bacteria.



Shoulder wound caused by bomb fragment. Energy deposit damage and contamination (right) was found on exploration of what seemed to be a simple wound (left).

In nearly all missile wounds there will be contamination of the wound by foreign material, usually clothing. When low energy transfer occurs the material is usually carried into the wound on the front of the missile and remains close to it. In high energy transfer wounds foreign material is literally sucked into the wound through both entry and exit wounds, disrupted into minute fragments, and then distributed along dissected tissue planes, sometimes as far as 20-30 cm from the track. Clothing material is invariably highly contaminated with organisms. If the gastrointestinal tract is breached the bowel contents are distributed into all parts of the peritoneal cavity and along the extra-abdominal track.



Gunshot wound of left shoulder with secondary tension pneumothorax.

Surgical exploration of high energy missile wounds is usually mandatory to remove dead tissue and foreign material and to provide ideal circumstances for the microcirculation to recover as rapidly as possible by ensuring that no tension develops in the wound. This may entail wide fasciotomy, leaving wounds open for delayed primary closure and preventing unnecessary movement, especially from unstable fractures. Although not a substitute for surgery, antibiotics may have an important role in helping to prevent infection, but these are effective only if given early.

The radiograph depicting blast lung is reproduced by kind permission of Mr R W Peyton and that of a gunshot wound to the shoulder by Mr J R Gibbons. The photograph depicting traumatic amputation and a shoulder wound caused by a bomb fragment and the radiograph showing cavitation have Crown copyright and are reproduced with the author's permission.

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